**CS 3160 Concepts of Programming Languages**

**Fall 2018 Assignment 4**

**Due 10-25-2018**

Choose all that applies for the following multiple choice questions.

1. What can types be used for?

a. Catch errors in the program early at compile time

b. Specialize efficient implementations of types at runtime

c. Help categorize the key concepts of programs into meaningful groups

d. Enable polymorphic functions

2. Which of the following are must-have components of a type system?

a. Basic types and their built-in operators

b. Compound types, their constructors, and operations to extract their values

c. Ways to determine whether two types are the same

d. Ways to introduce new types not already in the system

e. Ways to check whether each operation is applied to the correct types

f. Ways to convert one type to another

3. What is the difference between a transparent and an opaque type declaration?

a. A transparent declaration introduces a synonym for an existing type;

an opaque one introduces a new compound type that didn't exist before

b. A transparent declaration generates a new type name, an opaque one does not.

4. Which of the following is NOT an example of type errors?

a. An operation applied to the wrong type of values

b. An array being accessed out-of-bound

c. Null pointer dereference

d. A value intentionally casted to the wrong type

e. Dividing a value by zero

f. Converting an integer to a real (float) number

5. Which of the following type errors can be caught at compile time?

a. adding an integer with a string

b. An array being accessed out-of-bound

c. Null pointer dereference

d. A value being casted to an unrelated type

e. Dividing a value by zero

6. Map the following components to the information that they store.

Runtime stack dynamically allocated memory

Heap values of variables

Code Space the next statement to evaluate

code pointer instructions of the program

7. Which of the following is NOT a block?

(a) int foo(int x) { return x + 1; }

(b) (let ((a 1) (b 2)) (+ a b))

(c) let val a = 1; val b=2 in a + b end;

(d) for (var a in b) { print a; }

(e) x = x + 2; y = y + 2;

8. What value should be returned for the following ML code if static scoping is used? What value should be returned if dynamic scoping is used?

let val x = 3

in let fun foo(y) = x \* y

in let val x = 5 in foo(5)

end

end

end;

9. What is the result of the following pseudo code when each of parameter passing mechanisms, pass-by-name, pass-by-value, and pass-by-reference, is used?

int f (int x)

{

x := x+1; return x;

};

main() {

int y = 0;

print f(y)+y;

}

10. Draw a pictorial snapshot of the runtime stack memory for the following ML code.

1: val x = 1;

2: fun g(z) = x+z;

3: fun h(z) =

4: let x = 2 in

5: g(z);

6: h(3);